New Hampshire Volunteer Lake Assessment Program

2003 Interim Report for
Mascoma Lake
Enfield

NHDES
Water Division
Watershed Management Bureau
29 Hazen Drive
Concord, NH 03301

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **MASCOMA LAKE, ENFIELD,** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the lake/pond this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

  STATION 1: The current year data (the top graph) show that the chlorophyll-a concentration ***decreased gradually*** from June to August. The chlorophyll-a concentration on each sampling event was ***much less than*** the state mean.

  STATION 2: The current year data (the top graph) show that the chlorophyll-a concentration ***increased slightly*** from June to July, and then ***decreased*** from July to August. The chlorophyll-a concentration on each sampling event was ***less than*** the state mean.

It is important to point out that the mean annual chlorophyll at **STATION 1 and STATION 2** was ***approximately equal*** this season (and it has been in most of the previous sampling seasons).

Overall, visual inspection of the historical data trend line (the bottom graph) for **STATION 1 and STATION 2** shows ***a variable*** in-lake chlorophyll-a trend, meaning that the concentration has ***fluctuated*** *(but has not continually increased or decreased)* since monitoring began in 1991.

In the 2004 annual report, we will conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  STATION 1 and STATION 2: The current year data (the top graph) show that the in-lake transparency *was* ***stable*** from June to July, and then ***increased*** from July to August. At **STATION 1**, the transparency in June and July was ***less than*** the state mean, while the transparency in August was ***approximately equal to*** the state mean. At **STATION 2**, the transparency on each sampling event was ***less than*** the state mean.

Overall, visual inspection of the historical data trend line for **STATION 1 and STATION 2** (the bottom graph) shows ***a slightly decreasing (meaning worsening)*** trend for in-lake transparency, since monitoring began in 1991. It appears that the decrease is occurring at a slightly faster rate at Station 2 (which is the shallower station).

As discussed previously, in the 2004 annual report, we will conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  STATION 1: The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***increased*** from June to July, and then ***decreased*** from July to August. The phosphorus concentration in June and August was ***approximately equal to*** the state median, while the concentration in July was ***greater than*** the state median.

The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***slightly greater than*** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***decreased slightly*** from June to July, and then ***increased by a large amount*** from July to August. The concentration in August (226 ug/L) this season was ***much greater than*** the state median, and, in fact, was the ***highest*** phosphorus concentration that has *ever* been measured in the hypolimnion. The turbidity of the hypolimnion sample on the August sampling event was *not* elevated. Therefore, we consider this high reading to be *suspect*, perhaps due to sampling error or laboratory error. We will monitor the phosphorus in this location closely next season.

Overall, visual inspection of the historical data trend line for the epilimnion shows ***a relatively stable*** phosphorus trend, which means that the concentration has ***remained approximately the same*** in the epilimnion since monitoring began.

Overall, visual inspection of the historical data trend line for the hypolimnion shows ***a relatively stable*** phosphorus trend (except for the 2003 annual mean).

STATION 2: The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***remained stable*** from June to and August. (Due to a problem with sample bottle labels on the July sampling event, there was no phosphorus result for the July epilimnion sample.)

The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***approximately equal to*** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***decreased slightly*** from June to July, and then ***increased*** from July to August.

The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***slightly less than*** the state median.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion show ***a variable, but overall stable*** phosphorus trend. This means that the phosphorus concentration has ***fluctuated*** but has *not continually increased or continually decreased* at this station since monitoring began.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond.

The dominant phytoplankton species observed this year at **STATION 1** were ***Asterionella*** **(a diatom),** ***Tabellaria*** **(a diatom),** ***and Anabaena*** **(a cyanobacteria).**

The dominant phytoplankton species observed this year at **STATION 2** were ***Anabaena and Gleocapsa*** **(both cyanobacteria).**

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans. (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to nutrient loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of nutrient loading to surface waters.

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spots this season ranged from **6.08** in the hypolimnion to **6.96** in the epilimnion, which means that the water is ***slightly acidic.*** When organic material at the lake bottom is decomposed, acidic by-products are produced, which may explain the lower pH (meaning higher acidity) in the hypolimnion.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

- **Table 5: Acid Neutralizing Capacity**

Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion at **STATION 1 was 8.07 mg/L,** and at **STATION 2 was 8.33 mg/L**, which is ***slightly greater than*** the state mean. However, these data indicated that the lake is ***highly sensitive*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The conductivity has ***gradually increased*** at both deep spots since monitoring began in 1991. Specifically, the annual mean at **STATION 1 (87.4 uMhos/cm)** and at **STATION 2 (80.2 uMhos/cm)** this season were the highest annual means for these stations since monitoring began!

In addition, the annual mean conductivity this season at most of the tributary stations was the highest annual mean that had been observed since monitoring began.

Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the tributaries and in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride). Therefore, we recommend that the inlets with elevated conductivity be sampled for chloride next season.

Please note that there will be an additional cost for each of these samples, and these samples can not be analyzed at the satellite laboratory at Colby Sawyer College. Therefore, it would be best to collect the chloride samples during the annual biologist visit next season.

- **Table 8: Total Phosphorus**

  Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The total phosphorus concentration was ***slightly elevated*** in August at **La Salette Brook** (25 ug/L). The turbidity (Table 11) of the sample was also slightly elevated (4.0 NTUs), which suggests that the stream bottom may have been disturbed while sampling or that erosion is occurring in this portion of the watershed.

  When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***relatively high*** at all depths sampled at both deep spots of the lake/pond on the June sampling visit.

  As the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion (the lower layer) in **Mascoma Lake** by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it has been in many past seasons)**, the phosphorus that is normally bound up in the sediment may be re-released into the water column.

- **Table 11: Turbidity**
Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, the turbidity in the August **La Salette Brook** sample was ***elevated***.

- **Table 12: Bacteria (*E.coli*)**
Table 12 lists the current year data for bacteria *(E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms may also be present. events.

  The *E. coli* concentration was ***low*** (10 counts per 100 mL or fewer) at the **Swim Area** on each sampling event this season. This is ***much less than*** the state standard of 88 counts per 100 mL for surface waters that are designated public beaches.

  If you are concerned about bacteria levels at this beach, you may want to repeat this test next season on a weekend during heavy beach use or after a rain event. Since *E.coli* die quickly in cool pond waters, testing is most accurate and most representative of the health risk to bathers when the source (humans, animals, or waterfowl) is present. Most lakes and ponds typically have 10 or fewer counts of *E.coli* per 100 mL in open waters.

  The *E. coli* concentration at the **Dam Outlet** was elevated on the **June sampling** event, however, the concentration of 80 counts per 100 mL ***was much less than*** the state standard of 406 counts per 100 mL for recreational waters that are not designated beaches. On the **July** and **August** sampling events the *E.coli* result was 0 counts per 100 mL.

  The *E. coli* concentrations at the **Knox River Above Suspect** and **Knox River Below Suspect** sampling locations were elevated on the **June** sampling event (90 and 50 counts per 100 mL, respectively). However, these concentrations were ***much less than*** the state standard of 406 counts per 100 mL for recreational waters that are not designated beaches. On the **August** sampling events the E.coli results in these two locations were 2 counts per 100 mL or fewer.

And, the *E. coli* concentrations at the **La Salette Brook Above** and **La Salette Brook Below** sampling locations were elevated on the **June** sampling event (80 and 60 counts per 100 mL, respectively). However, these concentrations were also ***less than*** the state standard of 406 counts per 100 mL for recreational waters that are not designated beaches.

If you are concerned about *E. coli* levels at these tributary stations, your monitoring group should continue to conduct storm event sampling and bracket sampling along these tributaries. This additional sampling may help us determine the source of the bacteria.

For a detailed explanation on how to conduct rain event and bracketing sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake/pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a ***very good*** job when collecting samples this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few aspects of sample collection that the volunteer monitors could improve upon. They are as follows:

- **Sample Labels:** On the **July** sampling event, more than one sample bottle was missing a label and it was not possible for the lab or the volunteer monitors to determine which sample bottles corresponded to what sampling locations. It is possible that the volunteers may have forgotten to label the bottles or a non-waterproof pen was used, or the sample labels did not stick. Therefore, **five total phosphorus** bottles were rejected for analysis. Please make sure to label your samples with a waterproof pen (a black sharpie permanent marker works best), preferably before sampling. If your association has made its own sample bottle labels, please make sure to fold over one corner of each label before placing it on a sample bottle so that the label will not become permanently attached to the bottle. In addition, please make sure that the labels will stick to the bottles when they are wet.

- **Sample volume:** On the **July** sampling event, one of the *E.coli* bottles was not filled completely. Since a large air space was present in the bottle, the sample was rejected for analysis. Please make sure to fill *E.coli* bottles so that there are no air bubbles. This will minimize the potential for sample contamination.

NOTES

STATION 1

- **Monitor's Note (8/26/03):** Beautiful clear day

- **Biologist's Note (7/29/03):** 5 total phosphorous bottles were unlabeled and could not be tested: Browns Brook, Dulacs Brook, metalimnion, Sucker Brook not tested.
  (8/26/03): Hypolimnion total phosphorous sample had a result of 226. Test was repeated for confirmation of result.

STATION 2

- **Biologist's Note (7/29/03):** 5 total phosphorous bottles were unlabeled and could not be tested: epilimnion not tested.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, *NHDES-WD 97-8*, NHDES Booklet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. KennebecSoil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, *WD-SP-5,* NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, *WD-BB-9*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

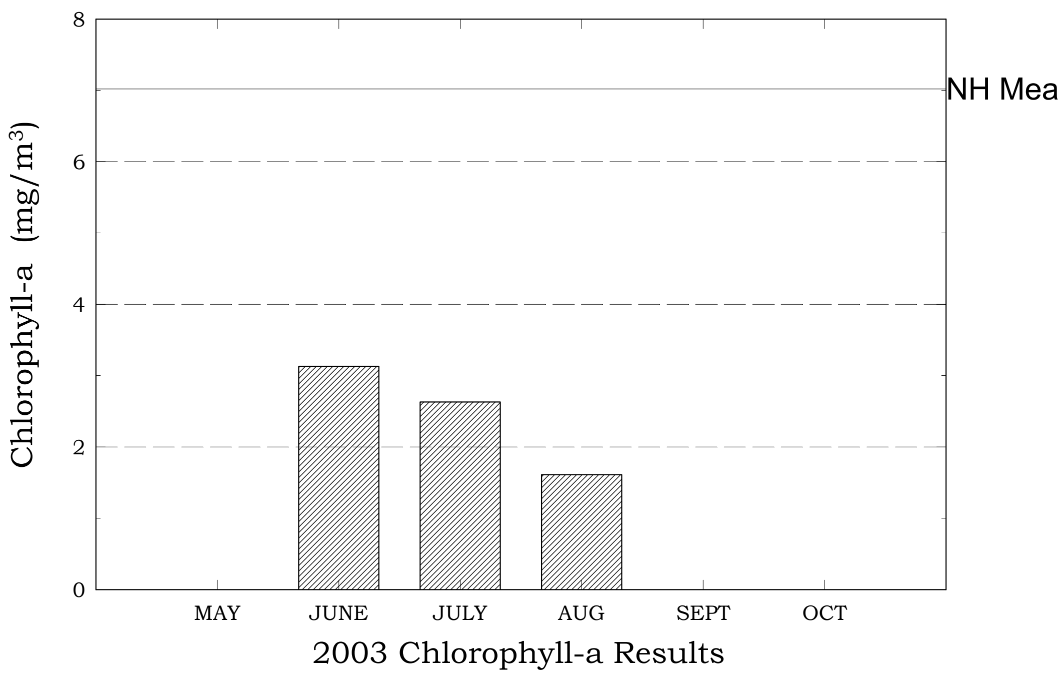
Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

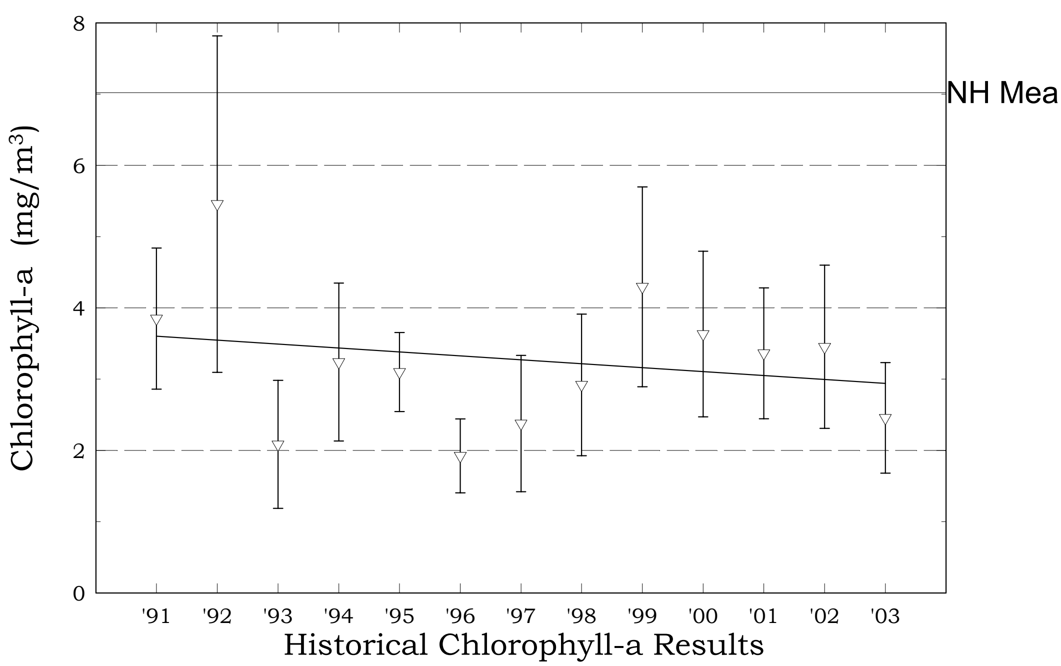
APPENDIX A

GRAPHS

Mascoma Lake, Stn 1, Enfield

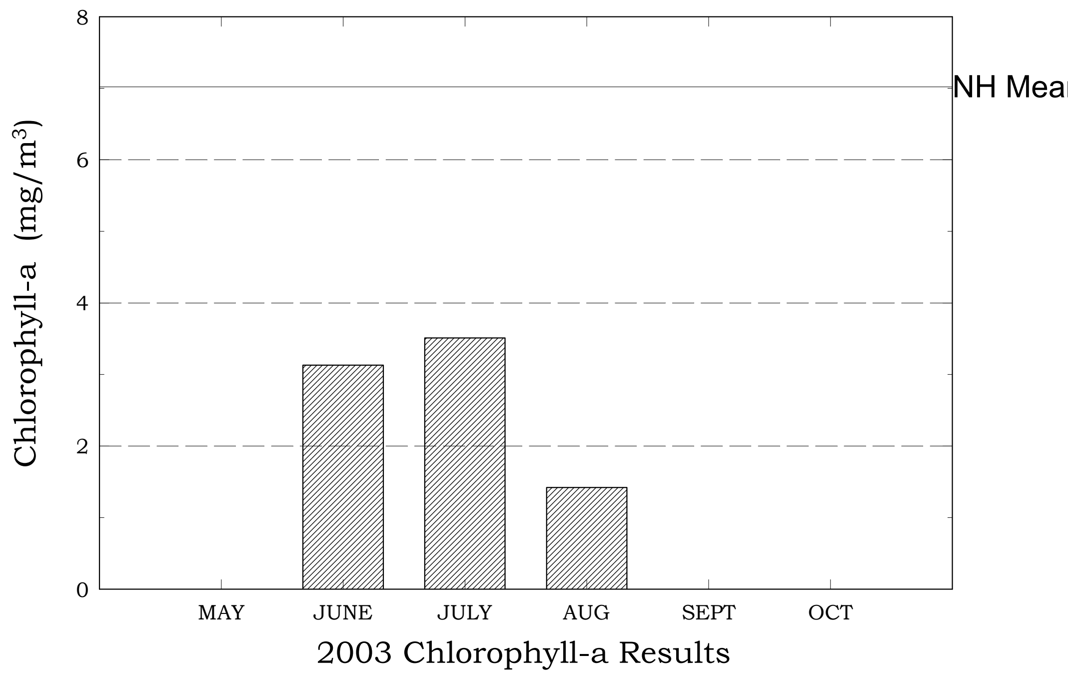
Figure 1. Monthly and Historical Chlorophyll-a Results

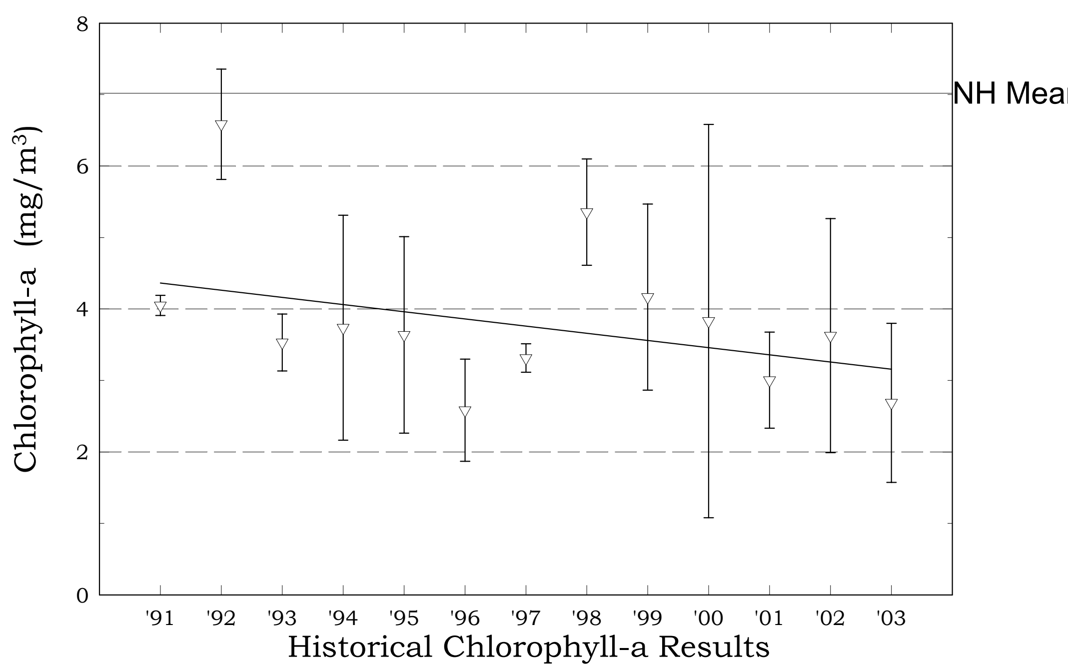




Mascoma Lake, Stn 2, Enfield

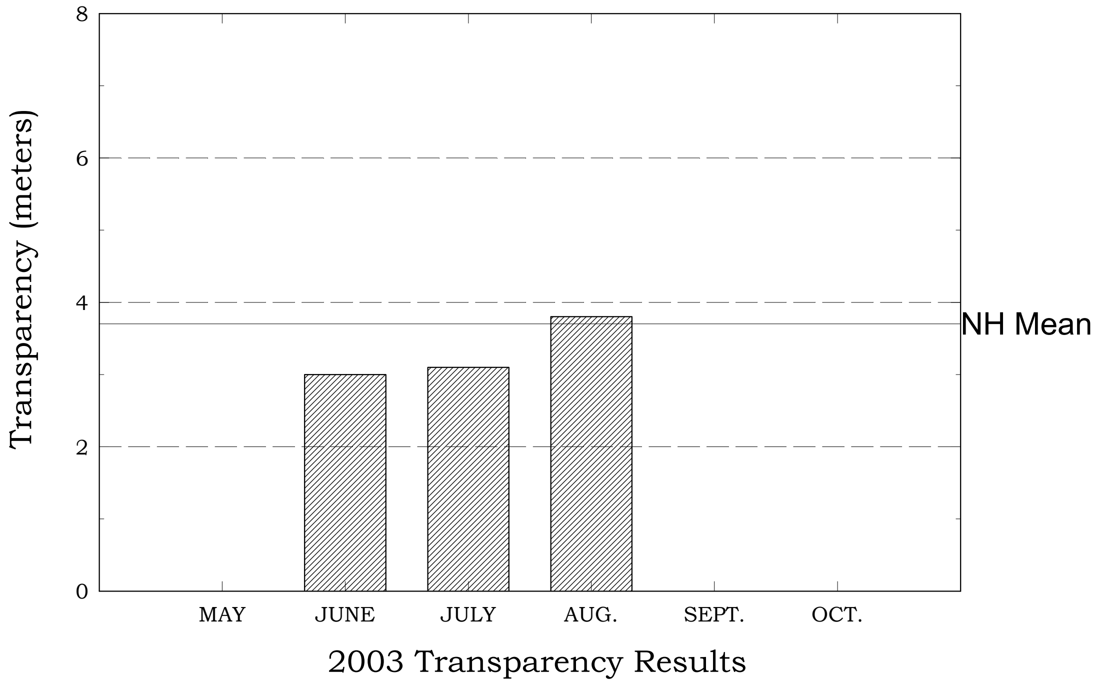
Figure 1. Monthly and Historical Chlorophyll-a Results

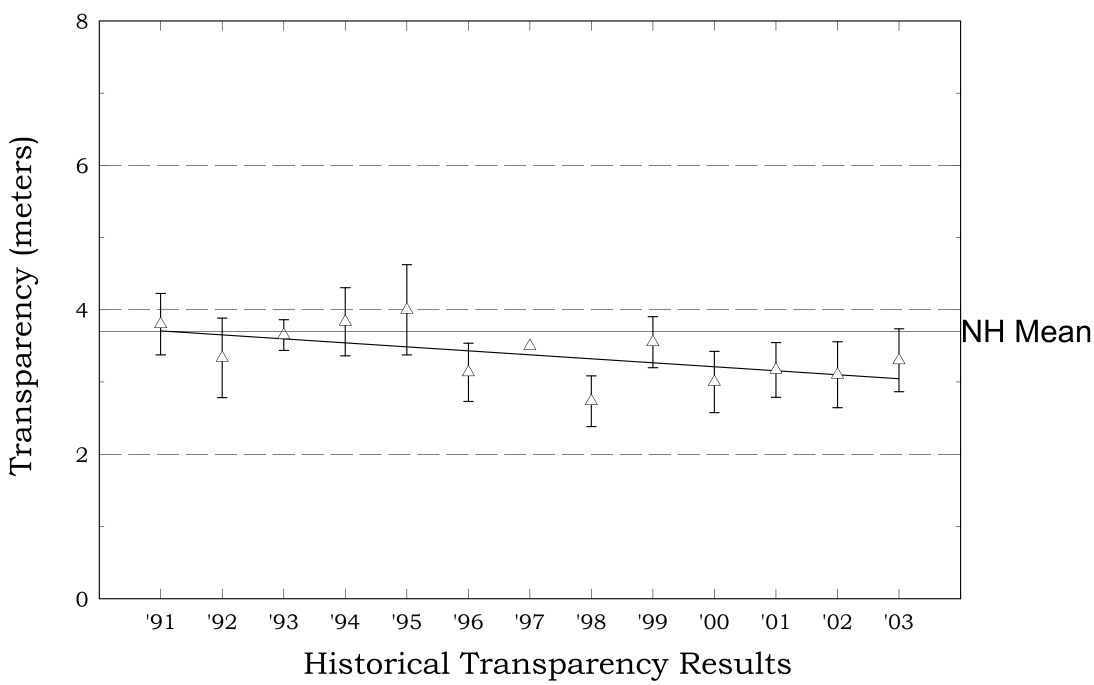




Mascoma Lake, Stn 1, Enfield

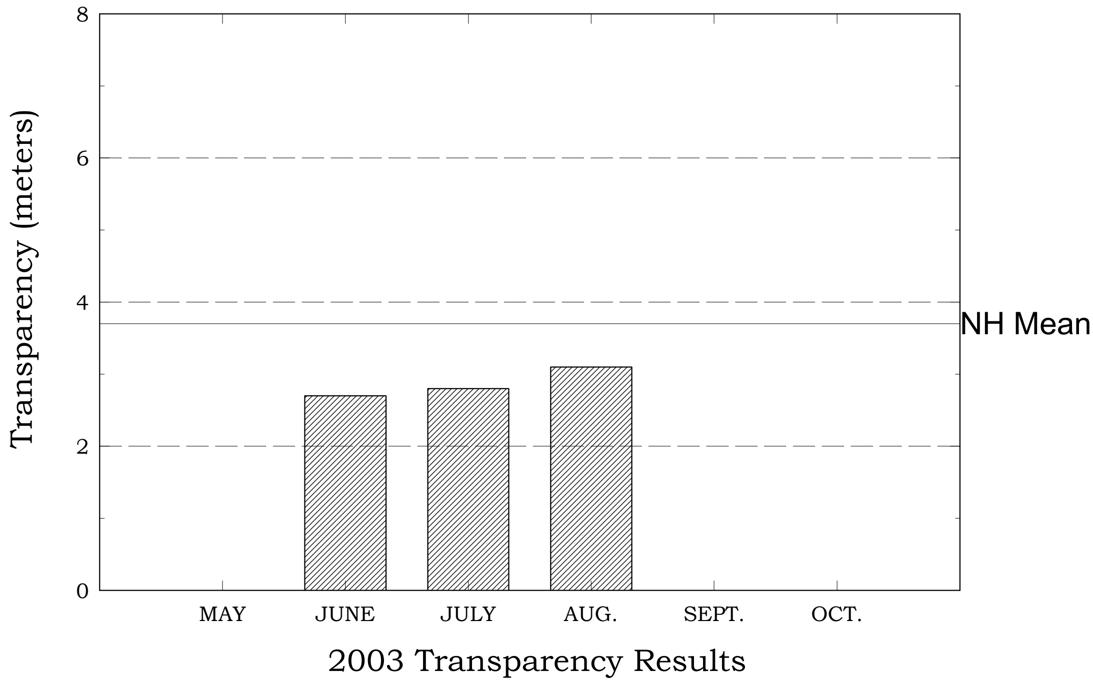
Figure 2. Monthly and Historical Transparency Results

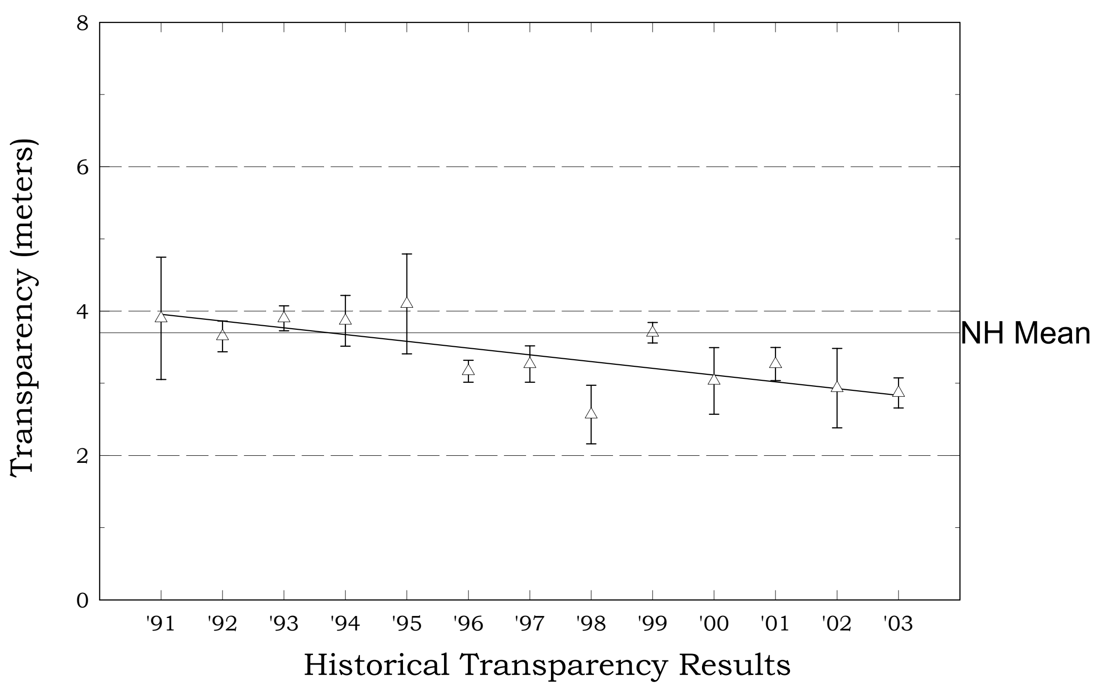




Mascoma Lake, Stn 2, Enfield

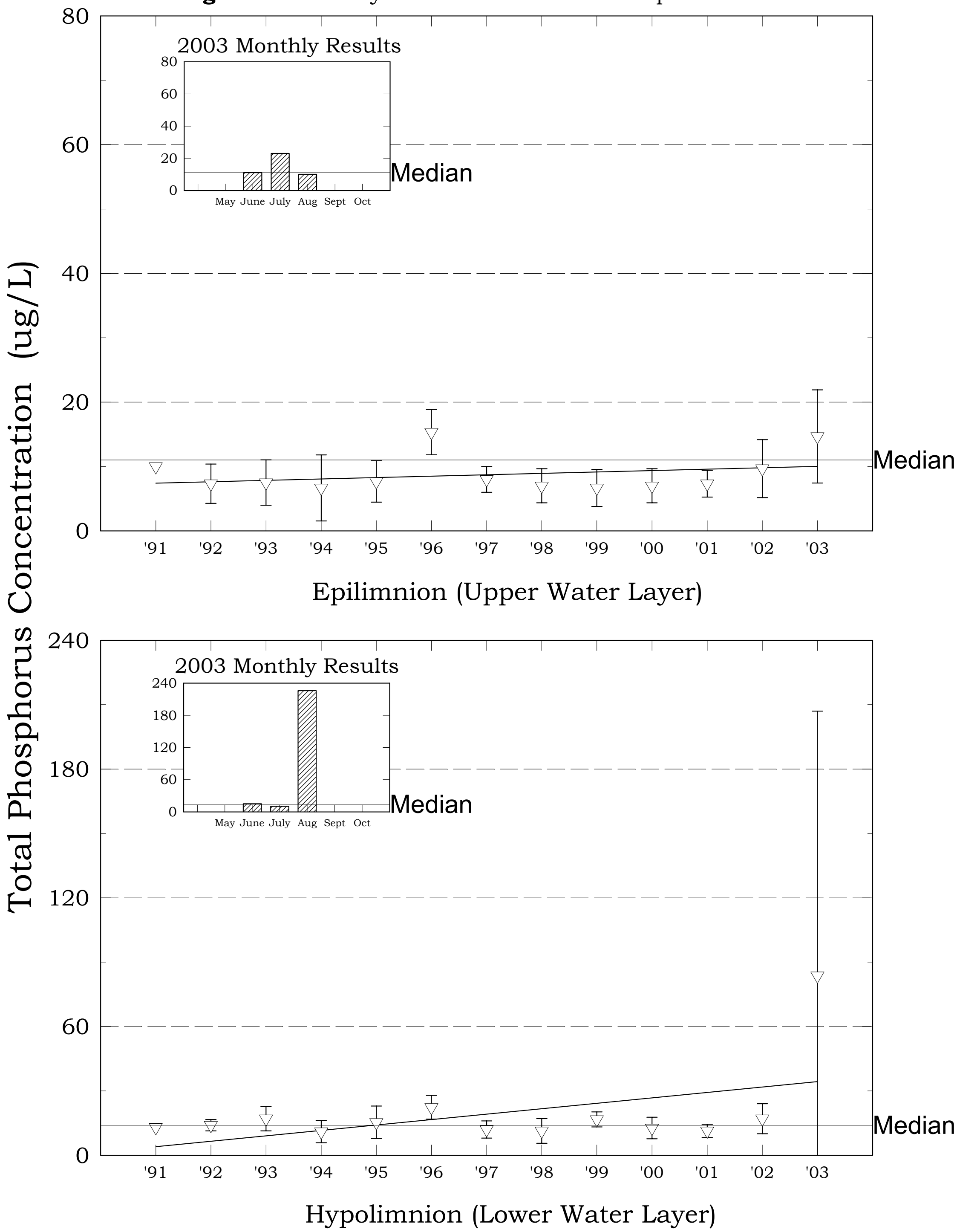
Figure 2. Monthly and Historical Transparency Results

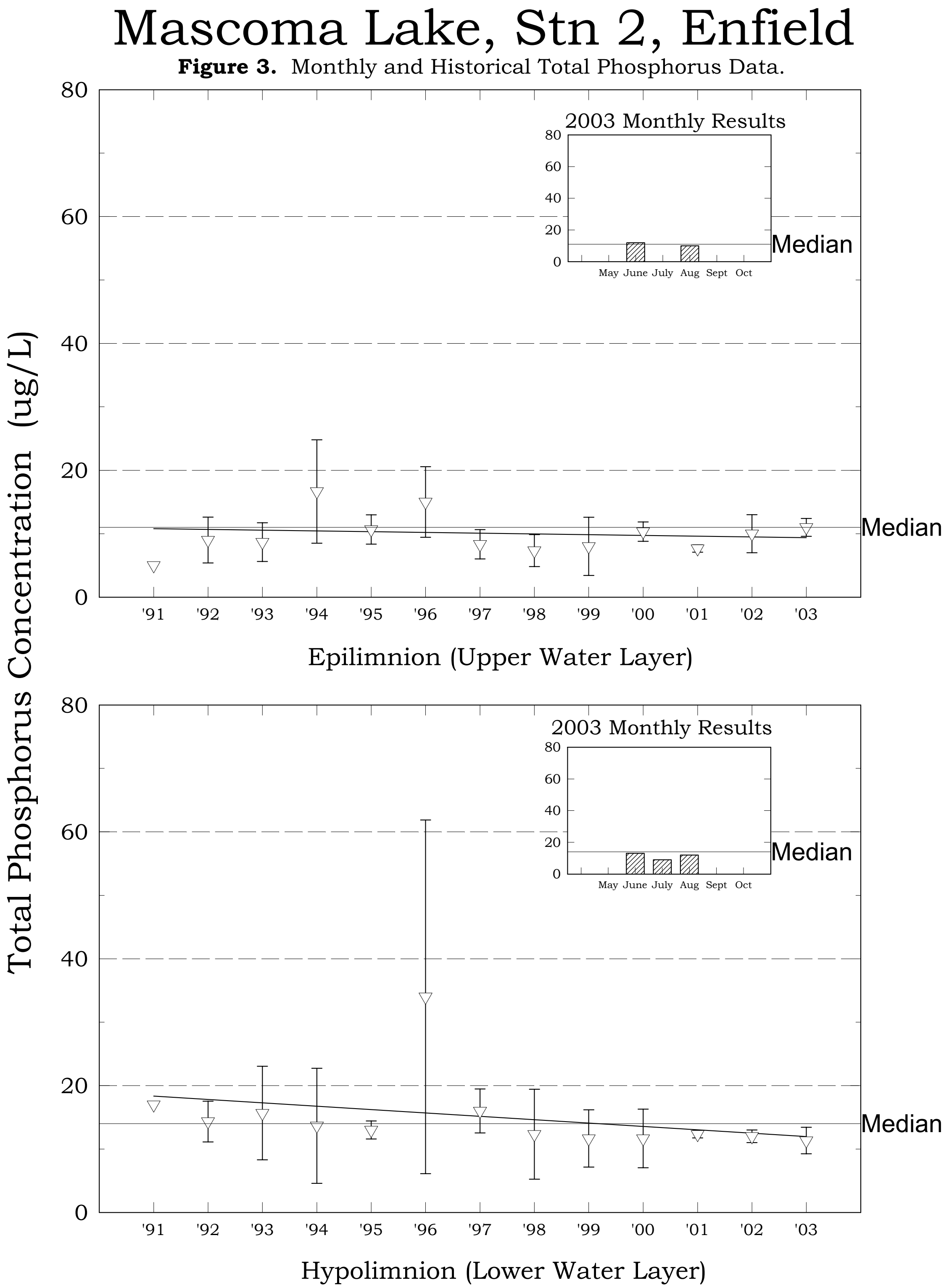




Mascoma Lake, Stn 1, Enfield

Figure 3. Monthly and Historical Total Phosphorus Data.




Mascoma Lake, Stn 2, Enfield
Figure 3. Monthly and Historical Total Phosphorus Data.
Total Phosphorus Concentration (ug/L)
2003 Monthly Results
Median
May June July Aug Sept Oct
'91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03
Epilimnion (Upper Water Layer)
2003 Monthly Results
Median
Hypolimnion (Lower Water Layer)